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LAND TENURE AND ECONOMIC PERFORMANCE OF AGRICULTURAL ESTABLISHMENTS IN NORTHEAST BRAZIL

By

Michael Sund

This paper is an abbreviated version of the author's Ph.D. thesis of the same title.

INTRODUCTION

Brazilians have long considered Northeast Brazil an economic problem area. As early as 1877, a special commission was established to inquire into the situation there, and shortly thereafter funds began to flow from the federal government for relief measures.[1/] Special treatment of the Northeast has continued sporadically, culminating in 1959 with the establishment of the regional development agency for the Northeast, SUDENE (Superintendencia de Desenvolvimento do Nordeste).

Prior to this date, the problems of the region were generally associated with recurrent and severe droughts. The resulting governmental response centered around public works relieving the effects of the most severe droughts. In fact, according to Hirschman, the timing and the level of federal government expenditures in the Northeast are directly associated with the occurrance of severe droughts.[2/]

In 1959, a commission was appointed to make a comprehensive study of economic conditions and possibilities of the region. This report, Uma Politica de Desenvolvimento Economico Para o Nordeste, led directly to the establishment of SUDENE. Brazilian economist, Celso Furtado, was instrumental in the drafting of the report and until recently headed SUDENE. His report and the establishment of this overall coordinating organ of the federal government recognized that the economic problems of the region were not solely associated with the drought and needed particular and continuing attention.[3/]

Among the many serious problems treated in the report were the economic organization and structure of agricultural production and the extremely low productivity in agriculture.[4/] It appears that the association of the Northeast's agricultural problems with the drought and the almost complete reliance on drought relieving measures and "after

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[1/] Albert O. Hirschman, Journeys Toward Progress, The Twentieth Century Fund, New York, 1963, p. 20. The commission was established as a direct result of the big drought of 1877-79. The first permanent organization set up to combat the effects of the drought was in 1909, the antecedent of DNOCS (Departamento Nacional de Obras Contra as Secas).

[2/] Ibid., pp. 20-21.

[3/] Conselho de Desenvolvimento Economico do Nordeste (CODENO), Uma Politica de Desenvolvimento Economico Para o Nordeste, Departamento de Imprensa Nacional, Rio de Janeiro, Brazil, 1959.

[4/] Ibid., pp. 18-21.

the fact" public works for employment purposes has lead to the negligence of the importance of the structural aspects of the economic organization of agricultural production. Many of these structural conditions are associated with the ownership, control and use of land. It is these aspects and their relation to agricultural development and economic performance which will be treated in this study.

In early 1963, the Inter-American Committee for Agricultural Development (CIDA) composed of the Food and Agricultural Organization of the United Nations, the Economic Commission for Latin America, the Inter-American Development Bank, the Organization of American States, and the Inter-American Institute of Agricultural Sciences, contracted with the Centro Latinoamericano de Pesquisas em Ciencias Sociais to conduct a study entitled "The Relationship Between Land Tenure and Economic and Social Development in Brazilian Agriculture. This particular research project was part of a larger project developing similar studies in six other Latin American countries.

The Land Tenure Center of the University of Wisconsin was invited to collaborate on the project both in the development of the methodology and in the field work. As a result of this arrangement, the author worked with the CIDA project in Brazil, and materials collected during the study provide the empirical basis for the present work.

Although the project included all of Brazil, this paper is limited to Northeast Brazil, and in part of the analytical portion to only three selected areas in the Northeast. This was done primarily to limit the problem to a more manageable size and to make possible an analysis in greater depth. It is not contended that the problems associated with the structure of agriculture in Northeast Brazil are essentially different from those in the remainder of Brazil. In fact, what differences do exist are more likely to be of degree of the problem rather than its nature.[5/] It is also readily admitted that in reality regions such as the Northeast cannot be separated from the rest of Brazil any more than can the agricultural sector be separated from the remainder of the economy. However, to make the problems manageable for analysis, artificial lines must be drawn.

5/ CIDA report yet to be published: The two southern states of Rio Grande do Sul and Santa Catarina are the only areas which show substantial differences from the normal pattern of land ownership in Brazil, thus, a slight exception should be made in the statement above.

THE FARM LABOR FORCE

The 1950 Census of Agriculture underestimated the number of persons working on farms, receiving no salary but only a piece of land in remuneration for the work done. In the explanation of concepts at the beginning of the 1950 Census of Agriculture, it was stated that subsequent analyses had proved that a number of persons in the above situation, locally called moradores, agregados, etc. was not enumerated and thus, comparisons between it and the 1940 census in terms of persons occupied would be somewhat hindered.

This phenomenon also shows up in a comparison of the proportions of the rural population considered as occupied in agriculture by the Census of Agriculture. The proportion is considerably lower in 1950 than in 1940 or 1960. This would indicate a substantial underestimation of the active agricultural population in the 1950 Census of Agriculture. Had they been enumerated, it is not certain into which category of agricultural workers discriminated by the Census of Agriculture they would have been placed. In 1960 an additional category was discriminated. This category simply included those workers who did not fit in the categories of permanent or temporary salaried workers or sharecroppers. Certainly, a majority of the types of workers described above would fall in this category in 1960. Thus, the simple total of persons occupied in the 1950 Census of Agriculture could not be used as an estimate of the active agricultural labor force.

Thus for this project the total number of farm workers was estimated in the following manner. The number of men 15 years and over was taken from the economically active category of "agricultura, silvicultura e pequaria" of the Population Census. The total of this sub-category of men over 15 was used. The remainder of the farm labor force (men under 15 and women) was taken from the category of persons employed in the Agricultural Census. Given the underestimation of the number of workers by the Census of Agriculture, it was decided to use the number of men over 15 from the Population Census because it was somewhat larger and it was assumed that this enumeration of essentially the same persons was made somewhat better.

For the remainder of the agricultural labor force the figures given in the Census of Agriculture for persons occupied were used simply because they were larger. All of the evidence that could be gathered indicated that most of the women and children over 10 years also worked, at least part time, in agriculture. Thus, the larger enumeration of the Agricultural Census appeared more reasonable.

Table 1. Specific Sources for Labor Force Data.

Socio-economic Category	Census Source
Operators and family members on latifundia	Agriculture
Operators and family members on multi-family medium-sized farms	Agriculture
Administrators	Agriculture
Professional employees	Population
Operators and family members on family farms	Agriculture
Specialized workers and foremen	Population
Operators and family members on sub-family farms	Agriculture
Sharecroppers	Agriculture
Permanent workers	Agriculture
Temporary workers	Agriculture
Other workers	Total minus all above

As can be seen from Table 1, the source of the discrimination of the total agricultural labor force into the various socio-economic categories is the Agricultural Census. The numbers for all the categories after which is written Agricultural Census came directly from the Agricultural Census statistics for 1950. The division of the operators of farms and their non-paid family labor force is based on the previous divisions of the farms into the four CIDA groups.

Two categories, specialized workers and foremen and professional workers, came directly from the Population Census. The category "other workers" is the difference between the estimate of the total number of workers in agriculture and those which were enumerated by the Census of Agriculture. This figure had to be reduced by the numbers in the two categories taken from the Population Census and by the number of administrators in order to avoid double counting and stay within the

limits of the estimate of the total number of workers in agriculture in the Northeast. The number of administrators had to be subtracted, even though the figure came from the Agricultural Census, because the owners of the farms on which there were administrators were not counted in the Agricultural Census and these owners were placed in the socio-economic categories. Thus, to avoid the double counting, a number equal to the number of administrators was subtracted from the category of "other workers."

The inclusion of the owners of the farms on which there were administrators assumes that these persons consider themselves dependent upon agriculture and, therefore, would be counted in the employment category of agriculture in the Population Census.

The number of administrators is not very large and the inclusion of the owners of the farms on which an administrator was enumerated as the responsável, only changes the proportions between the more privileged categories and the less and does not change the total number. Even these changes are very small, approximately 1 per cent.

In 1950, the total agricultural active labor force in Northeast Brazil was estimated to be 3,456,000. This is about 550,000 more than is shown in the Census of Agriculture as being occupied on agricultural establishments as of the data of the census. The difference included two groups of persons: (1) about 33,000 agricultural producers whose administrators were considered as responsible for running the farms and (2) workers who were not enumerated by the Census of Agriculture. (These workers have been divided into specialized, professional and other workers.)

Considered at the top of the scale are the producers and working family members of the multi-family large farms or latifundia. They comprise about 1.6 per cent of the total agricultural labor force and control over 53 per cent of all the land in farms in the Northeast. In the same general socio-economic category as the above group, that of persons who function primarily as employers but on a somewhat smaller scale, are the producers and working family members of the medium-sized multi-family establishments. This group is considerably larger, including 417,000 workers, or about 12 per cent of the total agricultural work force. They control about 40 per cent of all the land. The two groups together control over 93 per cent of all the land, while accounting for 13.7 per cent of the labor force.

About 33,000 of the above farms were managed by administrators. These coupled with professional agricultural workers such as agronomists, accounted for about 1 per cent of the agricultural labor force. It should be noted here that this category does not include all of the agricultural professional persons, only those considering themselves as working directly in agriculture and being paid directly by the proceeds of the farms on which they worked.

Family farmers and the working members of their families made up but 13.1 per cent of the labor force, or about 452,000 persons. This is about the same number of persons in the two groups of larger farms; however, the land controlled by the family farm group was slightly more than 5 per cent of the total compared to the 93 per cent controlled by the other two groups.

By far the largest proportion of the agricultural labor force, over 72 per cent, or almost 2,500,000 workers, fall in the lowest socio-economic category, that of sub-family farmers, their working family members, agricultural hired laborers, and sharecroppers. Within this category, the groups which can be distinguished are: (1) those who either own, rent, or occupy plots of land considered too small to meet the labor possibilities of a farm family and the other members of these families who work; (2) parceiros or sharecroppers and their working family members;[6/] (3) permanent workers; (4) temporary workers; (5) workers who were not classified by the Census of Agriculture. Of these five groups, temporary workers, with 25 per cent of the labor force, are the most numerous and permanent workers, with 7.3 per cent, the least. The more or less independent group and the group with the most management experience, the sub-family farmers, comprised slightly more than 17 per cent of the total labor force. As we saw before, they owned about 1.3 per cent of the land. In strictly ownership terms, over 70 per cent of the agricultural labor force owns only 1.3 per cent of the land in farms.

The distribution of the proportions in the various socio-economic groups, however, is not the same for all the states of the Northeast. The largest differences are in the distribution of those falling in the lowest category. First, in all the states in the Northeast this group comprised more than 67 per cent of the agricultural work force. In the states in which it rose to above 70 per cent, Pernambuco, Alagoas, and Maranhão, the proportion of minifundistas was alwo relatively large. In the other state with a relatively high number of minifundia, Paraiba, also had the fourth highest proportion of the labor force in this lowest socio-economic category. It appears that the proportion of minifundistas is directly related to the proportion of the labor force in the total group of sub-family farmers and workers.

Parceria is more common in the states of Ceará, Paraíba, and Rio Grande do Norte than in the others. In fact, almost 80 per cent of all the parceiros in the whole region were located in these three states. The only other state in which parceria is relatively common

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6/ The distinction between parceiros and small renters is a very subtle one. Generally the criteria would be independent management of the plot. In practice, it turns out that most renters pay a fixed sum of money and this determines their category.

is Piauí, in which almost 7 per cent of the agricultural labor force is classified as parceiros. In other states, parceria appears to have relatively minor importance. This seems to be directly associated with the fact that cotton, commonly grown under conditions of sharecropping, is much more widespread in the states of Paraíba, Ceará and Rio Grande do Norte, comprising nearly 45 per cent of the area dedicated to temporary crops in these three states in 1950 and only about 17 per cent in the remaining states.

In the states in which sugar cane is relatively more important, Pernambuco, Alagoas and, to a certain extent, Paraíba, the number of permanent workers is relatively large, reaching 13 per cent of all the active agricultural population in the former two and 7 per cent in the latter. Sugar cane in general is not produced under conditions of parceria, but with salaried workers, including a large number which are permanent.

Maranhão was the only state in which the proportion of workers classified as temporary was not extremely large, and even there it was nearly 19 per cent of the total labor force. In all the others, it was over 24 per cent, reaching 30 per cent in Alagoas. Because of more recent settlement in Maranhão, the older patterns of employment opportunities probably have not yet been fully established.

The category of unclassified workers, based on the enumeration of the Population Census seems to balance the numbers in this lowest socio-economic category. In the three states in which this proportion is high (accounting for one-fourth of all the workers in agriculture), the relative proportions in the other categories are low. Were it not for this category, the differences in the proportions of all the underprivileged workers among the states would be more marked.

The distribution of the active agricultural population among the remaining groups, producers and family workers on farms other than minifundia, administrators and specialized workers is quite similar throughout the Northeast. The proportion of producers and family members in the two multi-family farms groups ranges from 8.8 per cent in Maranhão to 20.1 per cent in Rio Grande do Norte. Excepting the state of Pernambuco, the number of persons working in these two classes is larger than the number of family farmers and their working family members; however, in most cases the differences were not extremely great.

Family farmers and their working family members comprised 8.5 per cent of the total agricultural labor force in Maranhão, the smallest proportion of all the states, and rose to 16 per cent in Pernambuco, the highest proportion. Over one-half of all the family farmers and their working family members in the Northeast were located in the states of Ceará and Pernambuco, and nearly three-fourths of Paraíba is also included.

The remaining group is that of administrators. The proportions of the agricultural labor force that are considered administrators vary from 1.4 per cent in Piauí and Ceará and 1.3 per cent in Rio Grande do Norte, to a low 0.6 per cent in Pernambuco and Maranhão. The proportion of administrators seems to be directly related to the proportions in the multi-family groups, indicating that a majority of the administrators are on large farms.

Considering the total agricultural labor force in the Northeast, the proportion which could be considered as underprivileged is much higher than the proportion which has adequate land resources. Some variations do exist among the states, but in general, the same pattern of agricultural employment exists throughout the Northeast--that of many workers with little or no land and few workers controlling the majority of it.

METHODOLOGY AND VARIABLES UNDER STUDY

To study land tenure institutions and their relationship to agricultural development and performance of individual farms in Northeast Brazil, three municípios were selected for closer examination. These were Quixadá in the state of Ceará, Sapé in Paraíba, and Garanhuns in Pernambuco. The municipios were selected to represent the three large geographical regions of the Northeast: Sapé in the humid coastal zone (zona da mata), Garanhuns in the sub-humid to semi-arid transitional zone called the agreste, and Quixadá in the semi-arid sertão. The municipios selected are relatively large and have fairly important commercial centers.[1/]

They were selected also as areas which represented specific agricultural and tenure problems. Quixadá is representative of the sertão cattle raising area with other crops, especially cotton being grown under systems of parceria, sujeição or by the salaried cowhands. Establishments in general are quite large and much of the area can be characterized as typical latifundia based on extensive agriculture.

Sapé in Paraíba was selected also because it was the seat of one of the largest Peasant League organizations with the potential for considerable social unrest. Although it is not wholly in the sugar cane zone, it has one of the largest usinas in the Northeast and the eastern portion of the municipio is largely dedicated to the growing of sugar cane.

[1/] Sizes are: Garanhuns 1,147 Km^2, Quixadá 4,841 Km^2, and Sapé 441 Km^2.

Garanhuns is a fairly typical agreste município with the predominance of a large number of very small property owners, a stage of fairly highly developed minifundismo. Along side the minifundia, there is a much smaller number of large establishments which in many cases are dropping more intensive cultivation (especially coffee) and are entering a system of livestock farming.

The establishments in each of these municípios were stratified by size according to the criteria developed for the CIDA study. A cross classification of size of establishment and persons occupied was requested from the Bureau of the Census of the Instituto Brasileiro de Geografia e Estatística. Using these data, the original data given in the traditional census size groups could be reclassified into the four CIDA groups. The results of the calculations are shown in Table 2. In each of the groups I through IV, the actual census questionnaires of approximately 100 establishments were selected. Later the size limits of the groups were adjusted to take into account temporary workers; thus, the numbers in the four groups do not correspond to the original 100 questionnaires selected. From these questionnaires certain relevant information was taken. More information could not be taken because of lack of time and resources.

Use of Census Questionnaires

Means were devised to divide the census questionnaires into the various institutional categories described in the preceding section.

First, the division into the various tenure groups, those of owner-producer, tenants, occupants and mixed condition[8] were taken directly from one of the questions on the census questionnaire referring to the legal condition under which the land is being operated, Condição Legal das Terras.

Whether or not the establishment was managed directly by the producer or through an intermediary, his administrator, was taken from the census classification of person considered in charge of the operation, Condição do Responsável. This was done only on those establishments which had proprio or owner-producer for the legal condition of the land in farms.[9]

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[8] The number of cases under mixed conditions was very small and they were included among the owners.

[9] The classification of the person in charge of a rented farm is always considered as a tenant, thus, all the administrators are on owned farms.

Table 2. Computations for Drawing Sample.

Município & CIDA Group	Hectares	No. of establishments in município	Persons employed per establish.	No. in sample
Quixadá				
I	0-5	303	2.9	63
II	5-50	1,177	6.5	109
III	50-500	842	12.3	108
IV	500 +	161	28.3	40
Total		2,483		320
Sapé				
I	0-5	1,747	2.5	185
II	5-20	363	5.0	83
III	20-200	72	11.7	34
IV	200 +	40	76.1	38
Total		2,222		342
Garanhuns				
I	0-5	5,969	1.9	103
II	5-20	3,177	4.0	99
III	20-200	925	10.9	177
IV	200 +	61	91.8	21
Total		10,132		400

To distinguish the institutions related to the way in which the labor force is organized, the question about persons employed was used. For each establishment, the labor force is discriminated into the following categories: the person in charge and his unpaid family members who work, permanent workers, temporary workers, sharecroppers, and others.

The first determination was to separate among the two large groups, those establishments on which the number of family laborers outnumbers the employed labor force, including sharecroppers. This defined the institutional group in which hired labor was not very important.

On the remaining establishments, those with hired labor force larger than the family labor force, a classification was made in accordance with the type of employment which predominated. Those in which the permanent employees were most numerous made up one category, those on which there were more temporary workers another, etc. In all, five categories were established: (a) family workers, (b) permanent salaried workers, (c) temporary salaried workers, (d) sharecroppers, and (e) other types of workers.

The distinction between categories (b) and (c) was made primarily because it was expected that a significantly larger portion of permanent workers (b) had access to a plot of land for growing subsistence crops than did temporary workers (c). Thus, the income distribution schemes differed somewhat among these two types of salaried workers.

The last category (e) is composed of those workers not included in the other four classifications. It should include those workers who received no salary for their work but rather parcels of land the produce of which is not shared with the landlord. Also, it is likely that persons working under the system of sujeição are included here, because in general, they are considered differently from salaried workers in the community, and are probably reported to the census taker in such a manner that he would place them in the "other condition" category.

The last institutional discrimination, that associated with size of establishment was automatically accounted for in the stratification for the selection of the sample. The various organizational forms of the labor force will be considered in only the two larger sized strata, those of multi-family farms and latifundia.

Variables Examined

(1) The first variable to be considered is the intensity of land use. More specifically, the proportion of the total land in farms which is dedicated to permanent crops, temporary crops and planted pasture will be calculated for each of the agricultural establishments. These proportions will then be examined to see if there are any differences among the various tenure and size divisions.

(2) Secondly, the use of pasture will be taken up. Considered as usable for pasture will be land in natural and planted pasture and productive land that is not in production, as this is most likely usable for pasture.[10] With respect to their use of pasture, animals will be considered as follows: cows, horses, mules and asses as one unit each, and sheep and goats as one-fourth of a unit each. Thus, all animals could be accounted for in general terms of their use of pasture. Many small establishments were not included in this analysis because the number of animals was quite small, a majority of cases were excluded because pasture land was not indicated.

(3) The third measure of economic performance will be productivity of land in terms of yields per hectare. For each of the establishments the most important crop in terms of hectares was selected. (Because of the lack of time and resources, not all the crops could be analyzed.) Yield per hectare comparisons will be made only for similar crops.

(4) Two measures of investment will be calculated. The first is investment as a proportion of total capital. The second will be investment per hectare. Included in the total capital is the value of land, thus, different values of land will be accounted for to some extent by the first figure.

(5) In order to obtain an idea of whether or not establishments are really in the money economy and to see to what extent inputs are purchased, the total expenses minus that paid for salaries, the value of the portion given to parceiros and rent will be computed and divided by the number of hectares. Those establishments for which this figure is zero are linked to the money economy only through the sales of produce. It is also some indication of the use of modern technical practices as a good share of these require money expenditures which would fall in this category.

(6) Two measures of capital were used. The first is simply the total capital per hectare. This would include past investments in machinery, buildings, cattle and land. The second is the same calculation subtracting the value of land.

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[10] Comissão Nacional de Política Agrária, Aspectos Rurais Brasileiros, Ministerio de Agricultura, Rio de Janeiro, 1955. The study indicated that land not being planted but cultivable is normally used for pasture. Land which was considered as wooded may also be used to some extent; however, there was no way of ascertaining this.

(7) Two other indications of progressiveness will be used. These are the use of fertilizers and the type of force used in the agricultural enterprise, that is, whether it is only human, animal, mechanic, or animal and mechanic.

The second group of variables discriminates among various categories and cannot be considered measures of performance. But they should be taken into account when considering the performance of the establishments indicated by the previous variables. They may also, to some extent, be considered as indicators of conditions under which certain types of establishments have to operate. Two such variables will be analyzed:

(1) One possibility of discrimination is the terms of rental contracts. Two computations will be made. First, the simple value of cash rent per hectare rented in each (or the value of a fixed quantity of production) will be computed. Secondly, where available, the value of rent as a proportion of the value of land rented will be determined.

(2) The simple value of land per hectare should be taken into consideration. This will be calculated, but the figures may have to be discounted somewhat, due to the fact that some owners may take more account of inflationary conditions than others or may consider declared values as having a relation to tax values, thus, making the veracity of the answer a bit questionable.

Statistical Tests

Where possible and reasonable, statistical tests will be employed to see if the differences in these variables among the various institutional groupings are significant. The test used will be the analysis of variance (F) test which compares the variance within the groups with that among the means of the various groups.

In addition to the analyses of variance, two multiple regressions will be computed, both in an additional attempt to explain the variance in the proportion of land under cultivation. Among the large farms, size of farm and value of land will be the variables used. On the family and sub-family farms, the number of workers per hectare will be substituted for size of farm.

ANALYSIS

Each of the indicators of economic performance will be taken up separately in order to see if there are any differences in various institutional categories. The analysis will show the relationship of size with each of the three other categories. In other words, the differences among size groups are examined three different times: first among all farms, second between only the two largest size groups, and thirdly, among only farms on which there were no tenants or occupants.

Intensity of Land Use

The measure used to indicate intensity of land use was the number of hectares of temporary and permanent crops and planted pasture divided by the total hectares in the farm. The including of planted pasture increases the proportion of land considered cultivated relatively more on the large farms than on the small ones. The percentages of land under cultivation for the various categories in the municípios of Quixadá, Sapé, and Garanhuns are shown in Table 3.

These percentages do not indicate the average amount of land under cultivation for the areas under consideration. Rather they are averages of the proportions for each farm. In order to obtain the average proportion of land under cultivation, they would have to be weighted by the actual size of the farms. Since in this analysis small farms are given equal weight, the resulting average proportions for the three municípios are over-estimations of the percentages of all land under cultivation.

In all three municípios, the size factor, when considering all four size groups and all the observations, was highly significant. The proportion of land under cultivation was consistently lower as size increased in all three municípios. In Quixadá, the average proportion of land under cultivation among sub-family farms was 95 per cent. In Sapé, it was 88 per cent and in Garanhuns, 90 per cent. For the largest farms, size category IV, the proportions were as follows: 11 per cent in Quixadá, 26 per cent in Sapé, and in Garanhuns, 32 per cent. The average proportions for size groups II and III, family farms and multi-family medium-sized farms, always fell between the sub-family farms and the latifundia.

Size of farm was also examined two other times, only among farms for which the owner was the producer, and with all farms but only in the largest two size groups. In the first case, that of owner-producers, the same pattern, relationship, and significance existed as did with all farms. However, when considering only the largest two size groups, the situation changes. Although the average proportion of land under cultivation in group III is higher in all three municípios than in group IV, only in Garanhuns is the difference significant.

Table 3. Intensity of Land Use - 1960. (Percentages*).

Area & Size	No.	Tenure**				Labor Force***						Administrator		
		P	R	O	T	A	B	C	D	E	T	No	Yes	T
Quix.														
No.		184	129	3	316	38	2	63	41	4	148	136	48	184
I	61	86.0	95.7	-	95.1	-	-	-	-	-	-	86.0	-	86.0
II	107	34.5	70.1	63.0	57.9	-	-	-	-	-	-	33.8	41.5	34.5
III	108	23.1	16.9	-	22.9	19.3	20.2	25.6	20.0	38.8	22.9	24.4	18.9	23.1
IV	40	11.3	2.8	-	11.1	6.7	-	13.9	10.5	-	11.1	10.7	11.9	11.3
Tot.	316	24.2	79.7	63.0	47.2	16.7	20.2	22.6	16.3	38.8	19.7	26.7	17.2	24.2
Factor		Size	Tenure		Int.	Size	L.F.		Int.		Size	Adm.	Int.	
F-ratio		39.698++	7.267++		7.495++	2.438	1.180		.062		16.958++	.051	.702	
Sape														
No.		172	162	4	338	9	47	10	1	4	71	90	81	171
I	184	75.6	93.0	100.0	87.9	-	-	-	-	-	-	68.8	93.2	77.0
II	83	71.6	63.6	7.7	67.8	-	-	-	-	-	-	44.2	95.9	71.6
III	134	54.5	42.7	-	53.5	24.9	63.5	51.3	68.2	-	53.5	32.8	72.5	54.5
IV	37	27.4	3.1	-	26.0	20.0	25.8	25.4	-	30.3	26.0	27.2	27.5	27.4
Tot.	338	60.8	85.3	77.5	72.7	24.4	43.4	33.2	68.2	30.3	39.2	49.3	74.3	61.1
Factor		Size	Tenure		Int.	Size	L.F.		Int.		Size	Adm.	Int.	
F-ratio		7.103++	2.135		5.645++	2.100	.968		.789		37.627++	57.495++	8.566++	

Continued next page.

Table 3. (Continued).

Area & Size	No.	Tenure**				Labor Force***						Administrator		
		P	R	O	T	A	B	C	D	E	T	No	Yes	T
Garan.														
No.		364	21	15	400	81	20	95	-	-	196	325	39	364
	103	88.9	95.1	100.0	90.3							89.4	80.3	88.9
II	99	62.1	53.5	75.4	62.2							62.9	49.7	62.1
III	177	40.9	37.7	6.8	40.0	33.1	48.8	44.1			39.7	40.9	40.8	40.9
IV	21	30.0		62.5	31.6	27.3	12.3	41.0			31.6	34.6	19.3	30.0
Tot.	400	56.7	74.2	66.3	58.0	32.8	39.7	43.7	-	-	38.8	58.3	43.7	56.7
Factor		Size	Tenure		Int.	Size	L.F.		Int.		Size	Adm.	Int.	
F-ratio		25.698++	.788		2.215	4.546+	1.809		2.199		18.238++	2.834	.630	

*Hectares of permanent and temporary crops, and planted pasture divided by total hectares in farms.

**P-proprietors, R-renters, O-occupants, T-total.

***A-family labor force, B-permanent salaried workers, C-temporary salareid workers, D-share-croppers, E-other workers.

+Significant at 5 per cent level.

++Significant at 1 per cent level.

In all three municípios tenants cultivated more of their land than did owner-producers or occupants. However, only in the município of Quixadá was the difference significant.

In Quixadá and Sapé small tenants cultivated more than small owner-producers and tenants on large farms cultivated less than owner-producers of farms of corresponding size. This gives rise to the significance of interaction of size and tenure in these two municípios.

With respect to proportions of land under cultivation, the various labor force systems on large farms indicated no significant differences. The major hypothesis to be tested here is that large farms on which the family labor force is larger than the hired labor force would have lower proportions of land under cultivation or, in other words, would be practically abandoned. These farms, labor force group (A), generally do have lower proportions of land under cultivation than the remaining categories, indicating that additional information might validate the hypothesis.

Only in the município of Sapé did the fact of having an administrator influence the proportion of land under cultivation. There, farms with administrators cultivated a larger proportion of land than farms run by their owners. However, there appears to be some confusion in the distinction between farms with administrators and tenants in Sapé. Many of the farms which indicated an administrator as the condition of the person in charge of the farm also indicated the payment of rent. These farms are very likely part of the sugar cane plantation and indicate their sharing operations with the usina as rent; however, they were not classified as tenants. They would either be lavradores da cana or fornecedores da cana, depending upon whether or not the usina owned the land which they were operating. This has served the usina as a way of decentralizing the management of a very large operation.

In the município of Quixadá, the proportion of land cultivated was about the same on farms with administrators as farms without, while in Garanhuns farms with administrators cultivated less than farms whose owners did their own managing.

In talking about the intensity of land use, the value of land should also be taken into account. The size and land value relationships appear logical, in comparison with those of size and percentage of land under cultivation. The smaller sizes have higher values per hectare of land and larger proportions under cultivation and vice-versa, especially when tenants and occupants are excluded. The tenure relationships, however, appear to be the opposite. The lower valued tenure categories have higher proportions under cultivation. They are, however, not very significant in either value of land or proportion of land under cultivation.

Pasture Utilization

Besides the proportion of land under cultivation, a second measure of land use can be obtained. This refers to the land used for pasture, and the measure of performance is the number of livestock units per hectare of pasture. Livestock units were calculated in the following manner: horses, cattle, donkeys and mules were considered as one unit each, while sheep and goats were considered as one-fourth a unit each. This is roughly equivalent to the carrying capacity of pasture for the various types of animals. The biggest problem with this calculation is that no account was taken of the age of the animals. Young stock which normally do not require pasture were counted equally with other animals.

Additionally, all farms which indicated more than five units of livestock per hectare were excluded from the analysis. Given the conditions of pasture in the areas under consideration, these farms either incorrectly indicated the amount of land used for pasture or were fattening operations. This procedure, of course, excluded all farms which indicated no pasture land, however, included those which indicated pasture land but no animals.

Considered as land usable for pasture was the number of hectares of planted pasture and natural pasture and the number of hectares of land cultivable but not under cultivation. The latter was included because other studies have shown that this land generally is used for pasture and certainly could be if it were not.

Considering an adjustment of 40 per cent for young animals not using pasture, the average number of livestock units per area of pasture is about one livestock unit per five acres in Quixadá, one for 3.5 in Sapé, and one for 4.8 acres in Garanhuns. The relationship among the municípios appears reasonable, however, the figures are probably all over-estimated.

Only in the município of Quixadá did any significant differences appear in the tenure and size categories. When all four size groups are included, the differences among them are significant, the levels of livestock units being higher on the small farms than on the larger farms In addition, owners appear to use their pasture more intensively than do tenants. The opposite situation with respect to tenure shows up in the other two municípios; however, the differences among the tenure categories were insignificant.

Respecting size, approximately the same pattern, large farms with less intensive pasture use, existed, but differences among the four groups were not significant.

The type of labor force system appeared to have no influence on pasture utilization, nor were there any significant differences between the two largest size groups; although in each município the averages indicated pasture use was less efficient on the larger of the two.

Productivity

On each of the farms one crop was selected to analyze productivity. The basis for this selection was the crop which occupied the most hectares. The total production for this particular crop was also available; consequently, productivity in terms of quantity harvested per hectare could be computed. In all cases except sugar cane, which is in metric tons per hectare, the yields are in kilograms per hectare.

The yields were, almost without exception, very low. For example, the average yield of corn in Garanhuns was 483 kilograms per hectare, which is about 8 bushels per acre.

Temporary cotton was the most important crop on enough farms to be analyzed in all three municípios. The yields again are generally low, but higher in more humid Sapé than in the other two municípios. In Quixadá there were no differences among the various size groups nor between tenants and owners. Also the difference between farms with administrators and those without was not significant. The significant differences which appear among the labor force distinctions indicate that farms with sharecroppers or permanent resident workers have higher yields than those using family labor or temporary workers. But these differences should be discounted as there is only one observation each in the first two groups.

In Sapé significant differences in size are found for all three situations in which it was analyzed. It would appear that the productivity of temporary cotton is greater on the larger farms than on the smaller. Again, however, the limited number of observations would make such a conclusion extremely questionable. The other institutional categories, security of tenure, system of labor force, and kind of administration had no relationship with yields.

In Garanhuns, none of the differences in yields of temporary cotton among the categories which could be examined were significant.

Beans were produced on enough farms in Quixadá and Garanhuns to be analyzed. Only among the tenure groups in Quixadá were the differences in the yields per hectare significant. Tenant operated farms were more productive than those operated by owners or occupants. The analysis was done over eliminating the one observation under occupants and the result between owners and tenants was even more significant. The conclusion, however, that tenant operated farms perform better

should be discounted somewhat for the lack of observations. The same relationship holds true for the other município, Garanhuns; however, the higher yield of beans on tenant operated farms was not significant.

Manioc or cassava was the most important crop on 107 farms in Sapé and 45 in Garanhuns. Most of these farms were small and no differences in yield among size or tenure groups existed.

In all the remaining crops analyzed, permanent cotton in Quixadá, sugar cane in Sapé and corn and coffee in Garanhuns, not one significant difference appeared in any of the size, tenure, labor force, or administration categories. In all of the analyses there were a sizable number of observations, giving rise to the doubts of the significance in previous cases where the number of observations was quite limited.

This would indicate that variance in yields per hectare among farms in any given category is much greater than the difference in yields among the tenure, size, labor force, and administration categories. Additionally, most of the yields are low and any difference among farms seems to be due to individual practices rather than the effects of any institutional arrangements under which the operator may be functioning.

Investment

Two measures of investment were computed. The first is investment as a proportion of total capital and the second is investment per hectare. Included in investment are purchases of machinery, cattle, the construction of buildings and their improvement, and the purchase of other goods of a durable nature. Capital consists of value of land, building, machinery, and other fixed assets. The proportion would give some idea of at what rate capital is being replenished.

In Quixadá, the average of the ratios of investment to capital was just under 5 per cent. If the value of land were excluded from total capital, the figure would slightly more than double. There were, however, no significant differences in the averages for size, tenure, labor force or administration categories.

In Sapé, the figure of investment divided by total capital was under 1 per cent. The value of land is about four-fifths of the value of all capital. Thus, the ratio would be about 4 per cent, should investment be compared with only the capital to which it adds.

In Sapé, differences among the four size categories among only owner-producer farms turned out to be significant. The results here indicated that large farms are investing more than small ones relative to the existing amount of capital. However, size groupings were not

important among all farms or between the largest two size groups. Thus, the size groups are not consistently important.

Investment was about 3.3 per cent of total capital in the remaining município, Garanhuns. If the value of land were excluded from total capital, it would increase to about 10 per cent, or about the same as in Quixadá. The only differences among the averages of the various institutional groupings in the size category among all farms. The very small farms and the very large farms appear to have invested larger amounts in relation to total capital than did family and multi-family medium-sized farms. The figures for very small farms, however, are influenced by a larger group of tenants who have probably underestimated or have very little capital. The analysis without tenants shows no differences among size groups.

Generally, when placed on a per hectare basis, investment shows relationships among size groups almost the contrary of that of investment divided by capital. Small farms generally have higher investment per hectare than larger ones. The only significant differences appear in the município of Quixadá and both are due to abnormally large observations in one cell. Among the labor force categories, farms with "other workers" had an investment per hectare figure of 10 times the average. Excluding this category, the differences are not significant. The same holds true for the smallest size group among only owned farms. The differences among the size groups would not be significant if the very small farms were omitted.

Thus, investment per hectare does not appear to be influenced by any of the established categories.

Expenses

The level of expenses per hectare was included to see if farmers purchased variable inputs such as fertilizers, insecticides, seeds and plants. The figure used is the total amount of expenses minus the amounts expended for salaries, rent, and payment to sharecroppers, which is included as an expense item when the sharecroppers are not enumerated as operators of separate establishments. Taxes are included in the computation of expenses used here, however, the amounts paid are very small and not likely to influence the results.

In all three municípios, the latifundia have the lowest level of expenses per hectare, and in two of the municípios the family farmers have the highest. In the other, the minifundia indicated the highest expenses per hectare. Only in the município of Sapé, however, were the differences significant and in this case only among the category of farms excluding tenants and occupants. Also tenants had an average expenses per hectare figure lower than on farms operated by the owners or their managers in all three municípios. The lower figures for

tenants were generally consistent throughout all four size groups in the three municípios, however, the differences were not large enough to be significant. Thus, there appears to be no particular difference in the orientation to the cash input markets among the size and institutional groups.

Capital

In order to obtain some idea of past investment on farms, the total amount of capital (including land) per hectare was computed. The remainder of the capital would include buildings, cattle, machinery and equipment and vehicles. The figure computed is the amount of capital on the farm and no judgment was made about its ownership. For example, the value of land is included on rented farms. It seems apparent that value of land is underestimated on tenant farms, giving rise to part of the tenure difference in total capital per hectare.

In Quixadá, there are significant differences among the four size groups of owners. The smaller sized farms have considerably more total capital per hectare than the larger ones. When tenants are included in their respective size group, the differences become insignificant. This is due to the fact that tenant operated farms have significantly lower levels of capital per hectare and there are many more tenants on small farms than on large ones. There appears to be no differences which are significant among the labor force groups, the use of an administrator or not, or size between the multi-family medium-sized farms and the latifundia.

In Sapé, practically the same results were obtained. Again the size groups were significant only among farms on which the owner was the producer. Size ceased to be significant when the other two tenure groups were included. The differences among the three tenure groups, however, were not significant. On the other hand, farms which had administrators as managers, rather than the owners, exhibited significantly lower levels of total capital per hectare than did the owner operated farms.

In Garanhuns, the same pattern as in the other two municípios existed. However, the differences among size groups in the owner category and those between owners and tenants were not significant. The only significant difference which appeared in the computation of total capital per hectare in Garanhuns was between the two largest size groups. The latifundia had significantly lower levels of capital per hectare than did the multi-family medium-sized farms.

In all three municípios and both relevant size groups of each, the large farms on which family labor was more important than hired labor showed levels of total capital per hectare lower than the other

kinds of labor force organization. Although it is not significant in any one município, the fact that it occurs in all three consistently would indicate some importance.

The second calculation using capital was to look at the same figures after deducting the value of land from the total amount of capital. This would be the value of buildings, cattle, and machinery per hectare.

Only in the município of Quixadá were significant differences among the size and institutional categories obtained. In this case, the patterns of differences were exactly the same as the computations before the value of land was deducted. In terms of capital other than land per hectare, tenant operated farms had significantly lower levels than did farms on which its owner was the producer. On these latter farms, the differences among the four size groups were significant with small farms having higher levels than large farms. Again the inclusion of tenant operated farms which are more numerous in the smaller size groups reduced the level of significance below 5 per cent. The elimination of land values from total capital increased the level of significance between the two largest size groups and differences became significant.

In general, in the other two municípios the differences in the average values of capital other than land were smaller and much less significant than when land was included. The same pattern of differences, however, still existed. Tenants have lower figures than owners, farms with administrators lower than farms without, large farms with only family labor force less than those with other systems, and small farms with higher levels than large farms. Only in Sapé did the pattern vary and there with respect to the size categories. The differences were very small and the levels did not become progressively smaller as the size of the farms increased.

Use of Fertilizer

An additional way of looking at the performance of farmers is their use of or failure to use fertilizers. The use of fertilizer does not necessarily link them to a factor market because organic fertilizer is also included in the responses of fertilizer use, and this may be produced on the farm if there are animals. However, most of the responses which indicated use of fertilizer also indicated some chemical fertilizer. Thus, in addition to an indication of more modern farm practices, it is an indication of cash expenditures and a closer link to the money economy.

Quixadá was omitted from the analysis as only one farm in the sample of 318 indicated use of fertilizer. Practically all use of fertilizer is on owned farms. Of all tenants and occupants in Sapé and

Garanhuns, only one indicated the use of fertilizer. Among the farms operated by owners or their managers, there are generally larger proportions using fertilizer on larger farms. Also, with the exception of the very large farms, a higher proportion of farms with administrators used fertilizer than those managed by the owner. On the latifundia, the opposite was true. Among the labor force groups, those with family labor force indicated very little use of fertilizer, less than any of the farms with hired labor forces. Also those farms on which the "other workers" category was predominant, had the highest percentage of fertilizer use.

In Sapé, 6.5 per cent of all farms in the sample used fertilizer. In Garanhuns this figure was 11.4 per cent. Among owners, the percentages were 12.1 in Sapé and 12.8 in Garanhuns. There were many more tenants in Sapé; hence, the large decline in the percentage when all the farms were considered. The percentages on latifundia rose to 44.7 per cent in Sapé and 33.3 per cent in Garanhuns.

It is interesting to note that there does not seem to be a relationship between a higher incidence of the use of fertilizer and higher crop yields. However, the extreme variability of the yields could easily account for this.

Use of Animal and Machine Power

The last of the variables examined was the use of animal or mechanical power in performing the tasks necessary to produce agricultural commodities.

Of the farms in the sample only 9.7 per cent of the sub-family farms in Quixadá, 0.5 per cent of these farms in Sapé, and 1.9 per cent in Garanhuns had the assistance of some animal or mechanical power in doing this work. Among the family farms the percentages differed very little, falling to 6.5 per cent in Quixadá, rising to 1.2 and 12.9 per cent in Sapé and Garanhuns, respectively.

On the other hand, considerably higher proportions of latifundia used animal and mechanical power. They rose to 32.5 per cent in group IV in Quixadá, 52.6 per cent in Sapé, and 57.1 per cent in Garanhuns. The average proportion of farms in the sample having other than human labor power was 16.2 per cent in Quixadá, 8.5 per cent in Sapé and 21.5 per cent in Garanhuns. Thus, practically all of the smaller farms in 1960 used only hand labor, while up to 50 per cent of the very large farms had some sort of animal or mechanical draft power.

With a few exceptions, the less secure tenure positions, tenants and occupants, had higher proportions of hand labor. In fact, most of them used only hand labor. There were practically no differences between establishments with administrators and those without. Also, the

use of only family labor force on large farms did not indicate that these farms were mechanized, reducing the necessity of hired labor.

Value of land

The first factor which was analyzed but not for the purpose of gleaning direct information about farm performance, was the value of land in thousands of cruzeiros per hectare. The major purpose of this analysis was to gain a better perspective for interpreting the results of the analysis of the performance variables.

The differences among the four size classifications within the group of only owner-producer farms was significant in all three municípios. In all three, the smaller farms have higher land values and the larger ones, lower, with consistent gradation in the intermediate size groups. Also in all three municípios the including of rent and occupied farms made the difference among the size groups insignificant. Thus, tenants whose incidence is much greater on small farms, generally have lower values of land than owners in the same size groups. However, only in Quixadá was the difference between owners and tenants significant.

The only other consistent difference in the value of land is among the labor force classifications. Those large farms on which the family labor force predominates have lower values of land than any of the other labor force organizations within the same size groups.

Rent

Finally, a short analysis of rent paid for the use of land and size of farm was made. It was done with two measures of rent: the value of rent divided by the value of land and the simple rental payment per hectare. Most of the rental arrangements were on small farms. However, differences were expected between even the two groups of small farms.

In Quixadá and Garanhuns, the minifundia pay slightly higher rents in comparison to land values than do family farmers. The differences, however, were not significant.

In Sapé the opposite occurred; however, the significance shown in Table 4 stems from the values in size group IV. This appears to be an obvious under-reporting of land values in group IV and the significance should be discounted.

In Quixadá, renters paid 5 per cent of the value of land as rent. In Sapé, deleting the two large farms, renters paid, on the average, 9 per cent of the value of land, and in Garanhuns, they paid 7 per cent of the value of the land they were renting.

Table 4. Rent Divided by Value of Land (1960).

Area & Size	No.	Average	
Quixadá			
I	2	.09	
II	45	.05	
III	-	-	Factor Size
IV	-	-	F-ratio 3.967
Total	47	.05	
Sapé			
I	118	.09	
II	25	.13	
III	2	.05	Factor Size
IV	2	.47	F-ratio 7.333++
Total	147	.10	
Garanhuns			
I	10	.10	
II	4	.05	
III	3	.00*	Factor Size
IV	-	-	F-ratio .291
Total	17	.07	

*Less than .005.

**Significant at 1 per cent level.

The figures of rent on a per hectare basis are shown in Table 5. These conform perfectly to the hypothesis that smaller farms pay higher rents. In Quixadá and Sapé, the differences among the size groups are significant. The per hectare rents in thousands of cruzeiros average .12 for Quixadá, 1.38 in Sapé and .49 in Garanhuns. These differences correspond generally to the differences in the climatic conditions for agricultural production among the three municípios.

Percentage of Land under Cultivation

Because intensity of land use appeared to differ significantly among the size groups, much more than productivity of land, it was decided to look a bit further into the differences. One of the difficulties was that the analysis of variance procedure did not take value of

Table 5. Rent per Hectare (1960). (Thousands of Cruzeiros)

Area & Size	No.	Average		
Quixadá				
I	5	.23		
II	46	.11		
III	-	-	Factor	Size
IV	-	-	F-ratio	62.154++
Total	51	.12		
Sapé				
I	132	1.42		
II	25	1.33		
III	3	.69	Factor	Size
IV	2	.77	F-ratio	2.784+
Total	152	1.30		
Garanhuns				
I	11	.63		
II	4	.39		
III	2	.12	Factor	Size
IV	-	-	F-ratio	.961
Total	18	.49		

+Significant at 5 per cent level.

++Significant at 1 per cent level.

land into account when analyzing the differences in percentages of land under cultivation among the various size groups. In addition, there was an association between size and value of land per hectare indicating that large farms, which had small percentages of land under cultivation, also had lower land values. Thus, in order to separate these effects and attempt to explain more fully the differences in the percentages of land under cultivation, a series of multiple regression analyses were set up.

The first regression, run separately for each of the three municípios, had percentage of land under cultivation as the dependent variable, and size of farm in hectares and value of land in thousands of cruzeiros per hectare as the independent variable.

In each município the farms were divided into two groups according to size. The division was made on the basis of the previous four size groups with the sub-family and family farms comprising one group, and the multi-family medium-sized farms and the latifundia, the other. This was done because it was felt that the decisions to cultivate more land were made differently on the large farms. This decision amounted to hiring more workers, mechanising, changing economic activity, etc. On these large farms a decision to cultivate more or less land could be made.

On the smaller farms, on the other hand, especially the very small farms, the decision to cultivate a higher proportion of the land in the farm probably depended more upon the size of the family and the need to provide subsistence for the family.

On these small farms, most of the land was under cultivation; thus, the decision to employ more workers in order to cultivate more of the land in the farm was not available. On the other hand, reductions in the proportion of land under cultivation also would not be very feasible as the subsistence of the family had to be met and work provided for the working family members.

For the large farms in the three municípios, the regression equations were as follows:

Quixadá	$Y = 17.9270 - .0069 X_1 + 2.2705 X_2$
Sapé	$Y = 24.7215 - .0031 X_1 + 1.7416 X_2$
Garanhuns	$Y = 36.7784 - .0209 X_1 + .4446 X_2$

where: Y = percentage of land under cultivation,
X_1 = size of farm in hectares,
X_2 = value of land per hectare in thousands of cruzeiros.

The complete results of the three regressions are shown in Table 6. The r^2's for explaining the variance in the proportion of land under cultivation were quite low. In Quixadá it was .22 and significant, in Sapé, .23 and significant, and in Garanhuns, .03 and not significant at the 5 per cent level.

In spite of the low regression coefficients, the relationships were as expected. As size increases, holding the value of land constant, the proportion of land under cultivation decreases. As the value of land increases, holding size of farm constant, the proportion of land under cultivation increases. In Quixadá both variables were significant; in Sapé only the value of land, and in Garanhuns, neither. In all of the cases the value of land appeared to be more important in explaining

Table 6. Regression Results. (Percentage of land under cultivation by size of farm and value on large farms.)

Município	Variable*	Mean	B	Standard error (B)	Partial Corr. (Coef.)^2
Quixadá	Y	19.2717	17.9270		
r^2 = .217	X_1	531.9694	-.0069	.0023	.069
	X_2	2.2365	2.2705	.5481	.127
Sapé	Y	40.8803	24.7215		
r^2 = .232	X_1	503.2915	-.0031	.0040	.009
	X_2	10.1699	1.7416	.4676	.170
Garanhuns	Y	39.3580	36.7783		
r^2 = .028x/	X_1	95.5031	-.0209	.0133	.013
	X_2	10.2992	.4446	.2829	.013

* Y = land under cultivation.

X_1 = size of farm in hectares.

X_2 = value of land in thousands of cruzeiros.

x/ = Regression not significant at 5 per cent level.

the intensity of land use than the size of farm.[11/]

The coefficient for the size of farm in Quixadá is -.0069. This would mean that for every 100 hectare increase in the size of farm, one could expect a .7 of 1 per cent drop in the proportion of land under cultivation. Since the range for size is large, from 50 hectares to 10,000, the coefficient would be expected to be small.

11/ Other evidence indicates that there is a probability of an underestimation of values on large farms. If this is true and if the underestimation is larger as the size of farm becomes larger, it is likely that size of farm would become more important in explaining the percentage of land under cultivation.

Similarly, for values of land, for every increase of 1,000 cruzeiros in value, the proportion under cultivation goes up 2.27 per cent. This is also quite reasonable as the ranges for value of land are quite small, reaching a high of about 8,000 cruzeiros. This would imply an increase of about 20 per cent of land under cultivation on the highest valued farms.

The slope for value of land was less in both the other municípios than in Quixadá, being 1.71 in Sapé, and .44 in Garanhuns. It was not significant in Garanhuns.

As was indicated before, size of farm was not used as an independent variable in attempting to explain the variance in the proportion of land under cultivation on small farms. It was noted previously that a number of farms of under 10 hectares had 100 or very close to 100 per cent of their land under cultivation. In these cases it was expected that the size of the family in relation to the size of the farm would be more important than the size of the farm alone. Rather than the size of the family, the number of persons working was used. Thus, this variable became the number of workers per hectare rather than the number of hectares. The value of land still remained as the second independent variable; however, it was not expected to be significant. Thus, for the small farms, those considered as family or sub-family sized, the hypothesis is that the percentage of land under cultivation is a function of the number of workers per hectare and the value of land.[12/]

Two other modifications were made in the actual regression analysis. It was expected that the relationship between workers per hectare and percentage of land cultivated, holding the value of land constant, would be a curve of the form $Y = X^{1/2}$. Thus, in order to get a better fit, the square root of workers per hectare was used rather than the simple number of workers per hectare.

Secondly, it was expected that the curve would be much flatter at high levels of workers per hectare, corresponding to 100 or nearly 100 per cent of land under cultivation. Thus, the groups of small farms for each of the municípios were divided into two parts: those with higher levels of workers per hectare and those with lower levels. The regressions were run separately for each group. The regressions were

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[12/] A significant partial correlation coefficient for the value of land, holding the number of workers per hectare constant, would imply that farms cultivate more or less land with the same number of workers as the value of land changes. The most plausible result would be a negative relationship with the value of land indicating higher valued land was used more intensively. This occurred in five of the six regressions run and the partial correlation coefficient was significant in only one.

also run with both groups together to see if dividing the groups gave better results. In Sapé and Quixadá results were better and logical; however in Garanhuns, the r^2 was considerably higher when the groups were run together.

For the three municípios the regression equations were as follows:

Quixadá (W/H large) $Y = 37.0463 + 47.1487 X_1 - .3085 X_2$

Quixadá (W/H small) $Y = -31.8722 + 170.8562 X_1 - .7264 X_2$

Sapé (W/H large) $Y = 76.9159 + 14.9491 X_1 - .3889 X_2$

Sapé (W/H small) $Y = 27.0995 + 81.1834 X_1 - .4536 X_2$

Garanhuns (W/H large) $Y = 70.3692 + 15.0824 X_1 - .1865 X_2$

Garanhuns (W/H small) $Y = 25.5291 + 50.9400 X_1 + .2580 X_2$

where: Y = percentage of land under cultivation,
X_1 = square root of number of workers per hectare,
X_2 = value of land per hectare in thousands of cruzeiros.

The complete results of the six regressions are shown in Table 7.

In all three municípios and in all six regressions, the variable, workers per hectare and value of land, explained small proportions of the total variance in the percentage of land under cultivation, ranging from 5 to 22 per cent. In all cases, except the small farms in Sapé with larger workers per hectare figures, the partial correlation coefficients were higher for workers per hectare than for value of land, and were significant.

The division of the farms in each município into two groups, on the basis of large and small levels of (W/H), appeared to be logical. In all three municípios the B for $(W/H)^{1/2}$ was much smaller in the group where workers per hectare was large. This would indicate that the curve is much flatter over the area where (W/H) is large and the percentage of land under cultivation approaches 100. Also it would be expected that when the proportion of land under cultivation is very high, the influence that changes in the numbers of workers have would be small, smaller than in cases in which the proportion of land under cultivation is smaller. This also appeared to be true. Except in the município of Quixadá where they are equal, the partial correlation coefficients for $(W/H)^{1/2}$ when (W/H) is large are considerably smaller than when (W/H) is small.

Because the regression was done using the square root of workers per hectare, Table 8 was constructed to show how the percentage of land under cultivation would change as the number of workers per hectare changes.

Table 7. Regression Results. (Percentage of land under cultivation by square root of workers per hectare and value of land on small farms.)

Município	Variable*	Mean	B	Standard error(B)	Partial Corr. $(Coef.)^2$
Quixadá	Y	84.7074	37.0463		
W/H (large)	X_1	1.0723	47.1487	13.2655	.162
r^2 = .163	X_2	9.3860	-.3085	.2967	.016
Quixadá	Y	62.2385	-31.8722		
W/H (small)	X_1	.5679	170.8562	45.1060	.161
r^2 = .161	X_2	4.0114	-.7264	1.6101	.003
Sapé	Y	86.6960	76.9159		
W/H (large)	X_1	1.1951	14.9491	8.4064	.025
r^2 = .122	X_2	20.7918	-.3889	.0982	.113
Sapé	Y	76.0430	27.0995		
W/H (small)	X_1	.6976	81.1834	15.0290	.189
r^2 = .218	X_2	16.9620	-.4536	.3123	.017
Garanhuns	Y	88.7427	70.3692		
W/H (large)	X_1	1.3658	15.0824	7.1084	.046
r^2 = .050 x/	X_2	11.9376	-.1865	.2194	.008
Garanhuns	Y	66.1078	25.5291		
W/H (small)	X_1	.6827	56.9400	17.8898	.085
r^2 = .087	X_2	11.8997	.2580	.3409	.006

* Y = percentage of land under cultivation.

X_1 = square root of workers per hectare.

X_2 = value of land per hectare in thousands of cruzeiros

x/ Regression not significant at 5 per cent level.

Table 8. Relationship Between Workers per Hectare and Land Under Cultivation.

W/H	Quixadá W/H (large) % Cult.	Quixadá W/H (small) % Cult.	Sapé W/H (large) % Cult.	Sapé W/H (small) % Cult.	Garanhuns W/H (large) % Cult.	Garanhuns W/H (small) % Cult.
0.0	35.05	-36.66	69.53	18.48	68.13	28.63
0.1	49.95	17.34	74.25	44.13	72.91	45.99
0.2	57.30	44.00	76.59	56.80	75.25	54.56
0.3	60.89	56.99	77.72	62.97	76.39	58.74
0.4	64.85	71.34	78.98	69.79	77.66	63.35
0.5	68.39	84.17	80.10	75.87	78.29	67.46
0.6	71.59	95.79	81.12	81.39	79.82	71.21
0.7	74.51	106.38	82.04	86.43	80.75	74.71
0.8	77.20	116.12	82.90	91.05	81.51	77.75
0.9	79.85	125.52	83.62	95.52	82.44	80.77
1.0	82.15	133.24	84.48	99.66	83.21	83.57

It can easily be seen that in all six regressions, the increase in the proportions of land under cultivation resulting from increases of one-tenth in the ratio of workers per hectare are much greater at low levels of workers per hectare than at higher levels. In Quixadá, in the regression in the group where (W/H) was large, for example, an increase in the workers per hectare from .1 to .2 is associated with an increase in the proportion cultivated of 7.4 per cent, while the same .1 worker per hectare increase from .9 of a worker per hectare to 1.0 worker per hectare results in an increase of only 2.3 per cent in the proportion of land under cultivation. All of these regressions have the same form, since they were computed using the square root of the number of workers per hectare. Thus, equal changes in workers per hectare are associated with varying changes in proportions of land under cultivation, depending upon the level of the variable, workers per hectare. The figures shown in Table 8 account for the value of land and hold it constant even though in all but one case it was not significant. In all cases the average

value of land for the two groups in each município was used to adjust the intercept or constant figure of the equation. Thus, for example, both columns for Quixadá were computed holding the value of land at 6,500 cruzeiros.

For purposes of comparison with the smaller farms, a regression of the square root of workers per hectare and value of land on the percentage of land under cultivation was also run with the large farms, those in size categories III and IV. The complete results are shown in Table 9.

First, as could be expected, the coefficients of regression for the large farms are greater than for any of the groups of smaller farms. The r^2 for Quixadá was .307, for Sapé .451, and for Garanhuns .268. These higher regression coefficients probably result from the fact that the proportions of land among these large farms seldom reach 100 per cent. As a consequence, there is no necessary range of (W/H) over which the percentage of land must remain nearly constant, as in small farm group approaching 100 per cent land under cultivation. Among these large farms the relevant range of workers per hectare does not reach one worker per hectare. In none of the municípios meeting the conditions of the regression equations shown below would the percentage of land under cultivation reach 100, assuming an average land value and (W/H) equal to one.

Quixadá $Y = 2.3102 + 53.4819\ X_1 + 1.6438\ X_2$

Sapé $Y = .3670 + 87.7117\ X_1 + .7327\ X_2$

Garanhuns $Y = 10.6566 + 62.1680\ X_1 - .0324\ X_2$

where: Y = percentage of land under cultivation,
X_1 = square root of workers per hectare,
X_2 = value of land per hectare in thousands of cruzeiros.

At the point where workers per hectare equals one and using the average value of land, the percentage of land under cultivation in Quixadá would be about 60 per cent, in Sapé about 94 per cent, and in Garanhuns about 62 per cent.

As in the case for small farmers, the relationship between percentage of land cultivated and workers per hectare is not linear. Thus, equal increases in (W/H) are associated with smaller increases of the proportion of land under cultivation at higher levels of (W/H).

Other evidence, plus the high association of workers per hectare and the proportion of land under cultivation, led to the hypothesis that large farms were not using technology which would enable each worker to cultivate more land. In other words, large farms, which had

Table 9. Regression Results. (Percentage of land under cultivation by square root of workers per hectare and value of land on large farms.)

Município	Variable*	Mean	B	Standard error(B)	Partial Corr. $(Coef.)^2$
Quixadá	Y	19.3273	2.3102		
$r^2 = .307$	X_1	.2494	53.4819	10.6435	.176
	X_2	2.2365	1.6438	.5395	.073
Sapé	Y	40.8803	-.3670		
$r^2 = .451$	X_1	.3853	87.7117	16.5581	.292
	X_2	10.1699	.7327	.4205	.043
Garanhuns	Y	39.3580	10.6566		
$r^2 = .268$	X_1	.4670	62.1680	7.6818	.256
	X_2	10.2992	-.0324	.2526	.000**

* Y = percentage of land under cultivation.

X_1 = square toot of workers per hectare.

X_2 = value of land per hectare in thousands of cruzeiros.

** .0000846

more land under cultivation, simply had more workers employed in some nearly constant proportion to the increase in the number of hectares cultivated.

In order to test this hypothesis it was necessary to rearrange the variables which were being used. It was set up with workers per hectare (W/H) as the dependent variable and with size of farm, value of land, and proportion of land under cultivation as the independent variables.

With this regression, a negative coefficient for size of farm would indicate that workers on large farms, on the average, are cultivating more land. The regression equations for the three municípios are as follows:

Quixadá $Y = .056044 - .000034 X_1 + .005418 X_2 + .001896 X_3$

Sapé $Y = .015972 - .000012 X_1 + .005378 X_2 + .003018 X_3$

Garanhuns $Y = .064006 - .000317 X_1 + .005896 X_2 + .004509 X_3$

where: Y = workers per hectare,
X_1 = size of farm in hectares,
X_2 = value of land per hectare in thousands of cruzeiros,
X_3 = percentage of total land under cultivation.

The complete results of the regression are shown in Table 10. As can be seen from the equations, in all three municípios, the coefficient for size is negative, indicating that workers are handling more land. However in Sapé, the coefficient is not significant, and in the other two municípios, the partial regression coefficients indicate that size explains only about 4 per cent of the variance in workers per hectare when value and percentage of land under cultivation are held constant.

Additionally, the coefficients for size of farm are very small indicating very small changes in the ratio of workers per hectare for given changes in size of farm. In Quixadá the average number of cultivated hectares per worker on these farms is under 2.5 hectares and for Garanhuns slightly under 2 hectares.

To obtain some idea of the relationship between size and workers per hectare of cultivated land, it was decided to determine how much of an increase in total hectares would be related to an increase of one hectare of cultivated land per worker. Assuming the average values for the two equations for value of land and the percentage of land under cultivation, and adjusting the intercept accordingly, in Quixadá an increase of one hectare of cultivated land per worker would be associated with an increase of approximately 770 hectares of total land in farms and in Garanhuns, about 410 hectares. These figures are quite large, indicating that over reasonably large ranges of size, there is very little change in the ratio of workers per hectare of cultivated land. Thus, although in two of the municípios there was a significant negative relationship between size of farm and workers per hectare holding the percentage of land under cultivation and value of land constant, technology permitting workers to handle more land, does not change very much as size of farms increases.

In addition, in all the three municípios, the variable which explained by far the largest part of the variance in the number of workers per hectare in farms was the proportion of land under cultivation.

Lastly, in an attempt to explain as much of the variation as possible in the proportion of land under cultivation, three independent variables were used: the size of farm, the square root of workers per

Table 10. Regression Results. (Workers per hectare by size of farm, value of land, and percentage of land under cultivation on large farms.)

Município	Variable*	Mean	B	Standard error(B)	Partial Corr. (Coef.)^2
Quixadá	Y	.0869	.05604447		
r^2 = .253	X_1	531.9694	-.00003364	.00001407	.046
	X_2	2.2365	.00541808	.00340491	.021
	X_3	19.3273	.00189578	.00053434	.097
Sapé	Y	.1879	.01597207		
r^2 = .445	X_1	503.2915	-.00001215	.00002028	.005
	X_2	10.1699	.00537897	.00262292	.059
	X_3	40.8803	.00301757	.00061997	.261
Garanhuns	Y	.2719	.06400576		
r^2 = .300	X_1	95.5031	-.00031684	.00011351	.039
	X_2	10.2992	.00589559	.00240792	.027
	X_3	39.3580	.00450913	.00061347	.222

* Y = workers per hectare.

X_1 = size of farm in hectares.

X_2 = value of land per hectare in thousands of cruzeiros.

X_3 = percentages of land under cultivation

hectare, and the value of land. The regression was done including all the farms in each município. The results of the regression are shown in Table 11.

Using all three independent variables, the overall regression coefficients still remained small. Only from 33 to 40 per cent of the variance in the percentage of land under cultivation could be explained by the size of farm, the value of land and the ratio of workers to hectare of total land in farms.

Table 11. Regression Results. (Percentage of land under cultivation by size of farm, value of land and square root of workers per hectare.)

Municipio	Variable*	Mean	B	Standard error(B)	Partial Corr. ^{2} (Coef.)
Quixadá	Y	48.514	10.360		
	X_1	247.944	-.007	.005	.007
r^2 = .357	X_2	.552	75.560	7.740	.266
	X_3	4.576	-.405	.314	.006
Sapé	Y	72.491	45.792		
	X_1	114.165	-.014	.003	.049
r^2 = .327	X_2	.822	45.812	4.496	.244
	X_3	16.963	-.554	.089	.108
Garanhuns	Y	58.500	23.131		
	X_1	49.936	-.017	.013	.004
r^2 = .402	X_2	.744	48.014	3.358	.344
	X_3	11.123	.045	.162	.000**

* Y = percentage of land under cultivation.

X_1 = size of farm.

X_2 = square root of workers per hectare.

X_3 = value of land.

** .0001932

SUMMARY AND CONCLUSIONS

In Northeast Brazil, agricultural productivity is low measured either in yields per hectare or yields per agricultural worker. It is lower than in other sections of Brazil.

At the same time, agriculture is dominated by the latifundia-minifundia complex. Land ownership is highly concentrated, probably higher than official figures indicate because multiple ownership is not taken into account. Latifundia, defined as farms which on the average would provide full-time employment for 12 or more persons, control 53 per cent of the land in Northeast Brazil. These farms combined with the multi-family medium-sized farms occupy 93 per cent of all the farm land in the Northeast and represent only 28 per cent of the agricultural establishments. On the other hand, sub-family and family farms occupy only 7 per cent of the land and comprise 72 per cent of the agricultural establishments. Concentration ratios of land holdings in 1960 ranged from .7516 in Ceará to .9200 in Maranhão, with the average for the Northeast being .8677. This is slightly larger than the figure for 1950, indicating that no attenuation in the concentration of land holdings has occurred during the decade.

Aside from the states of Maranhão and Piauí, most of the land suitable for agricultural purposes is already incorporated in farms, limiting the possibility of settlement on public lands.

The proportion of land under cultivation is small. Of the total territorial area in the Northeast, only 5 per cent was cultivated in 1950 and of the land in farms only 10 per cent. The proportion of land cultivable but not under cultivation in all of the states is larger than that actually under cultivation. For the region it is nearly three times as great. The proportion of land under cultivation varies with the size of farms. On sub-family farms 71 per cent of the land was under cultivation in 1960, while on the latifundia only 6 per cent.

The agricultural labor force is large in relation to the land under cultivation, leaving only 1.5 hectares of cultivated land per person working in agriculture for the whole region and reaching only 1.2 hectares in the more densely populated states of Alagoas and Pernambuco. New estimates were made of the number of persons working in agriculture in the Northeast. The estimates were placed into socio-economic categories. The lowest category, that of operators of sub-family farms, sharecroppers and salaried workers with or without land, amounted to 2.498 million workers, and 72 per cent of the total agricultural labor force. Those occupying the more privileged position, owners and their working family members on multi-family farms amounted to only 14 per cent of the agricultural work force. Operators of family farms and their working family members accounted for most of the remainder.

The tenure condition of the operators of agricultural establishmen varied with the size of establishment. The less secure tenure position were more concentrated on smaller farms. Administrators, in general, were on larger farms, although there apparently are a number of very small farms run by administrators. Tenants were more numerous in the states of Pernambuco and Alagoas, while almost all of the occupants were in Maranhão.

For a detailed investigation of these conditions, a sample of questionnaires was taken from the 1960 Brazilian Census of Agriculture. The sample included about 1,060 questionnaires from three municípios in the Northeast: Quixadá located in the more arid sertão in the state of Ceará Sapé in the sub-humid coastal zone in the state of Paraíba, and Garanhuns in the transitional agreste area in Pernambuco. The areas were selected to represent the three large geographic areas in the Northeast.

Each questionnaire corresponded to an agricultural establishment. The farms were classified according to size into four groups, sub-family farms, family farms, multi-family medium-sized farms and latifundia. The classification was made on the basis of the capacity of the size of farm to employ full time workers using existing technology. Secondly, tenure institutions in the Northeast were described and the farms further classified according to security of tenure, type of labor force arrangement, and kind of administration. Analysis of variance tests were made among these classifications to see if there were significant differences among them, using various measures of agricultural performance. Few significant differences occurred.

Only in the município of Quixadá were the differences among the tenure categories significant. The less secure tenure forms, those of tenant operated farms and occupants had larger proportions of land under cultivation, lower efficiency of pasture use, smaller levels of both total capital per hectare and capital other than land per hectare, lower land values, and no use of fertilizer among the sample farms. In most cases in the other two municípios the difference in the variables were in the same direction. However, none of them was significant.

There were no differences in yields between the tenant operated farms and those operated by their owners, nor were there any differences in the measures of investment or expenses. Rent per hectare appeared to be higher on smaller farms, but rent in terms of value of land did not.

On the large farms, five labor force distinctions were made: (A) farms on which family labor predominated, (B) permanent salaried workers, (C) temporary salaried workers, (D) sharecroppers, and (E) other workers, generally thought to include workers who received no salary but only the use of a plot of land in return for working for the owner several days a week. No significant differences among these

groups appeared in any of the performance indicators. The only hypothesis that appeared to be plausible was that farms on which the family labor force outnumbered the hired labor force were less intensively exploited. They had lower levels of percentages of land under cultivation, in most cases lower yields, lower total capital per hectare, lower capital other than land per hectare, lower investment per hectare, a lower incidence of the use of fertilizer and a higher proportion using only human labor power. At the same time, however, they reported lower values of land, and although fairly consistent, none of the differences was significant.

The hypothesis that farms using sharecroppers who have a more direct stake in the productivity of the farms than salaried workers would have higher yields was not validated.

The fact of absenteeism and its corollary, the use of administrators to manage the farms appeared to have little influence with any of the economic indicators. The only significant differences occurred in the municipio of Sapé in which there was some confusion about the classification of administrators. It appeared that many of them should have been classified as tenants.

Size of farm appeared to be more important than any of the institutional classifications. Small farms cultivated a larger proportion of their land, they had more capital per hectare, generally used pasture more efficiently, had lower investment per capital, lower incidence of the use of fertilizer, and a higher proportion of farms using only hand labor. However, yields per hectare of various crops were not different and the small farms reported values of land higher than larger farms.

On large farms, classified as being larger than necessary to employ the labor force of a farm family, the proportions of land under cultivation are more closely associated with the values of land than with the size of farms. However, the relationship of size to proportion of land under cultivation was negative in all three municipios and was significant in one of them, indicating at least in that municipio with equal values of land, the proportion of land cultivated on larger farms is lower.

The most important variable, however, in explaining the proportion of land under cultivation was the ratio of workers to total hectares. In all municipios and among all sizes of farms, it was highly associated with the proportion of land under cultivation. However, workers per hectare explained less of the variation in the proportion of land under cultivation on the very small farms than it did on larger ones. This is evidence that other considerations have more importance in determining the amount of land cultivated on small farms, very likely the necessity of meeting the subsistence of the family. It would also indicate the possibility of the more work off the farm for the workers on very small farms.

On the larger farms it was hypothesized that there was nearly a constant ratio of cultivated land to number of workers, and that larger farms used no different technology enabling workers to cultivate more land than on smaller farms. In one municipio, the factor size was not significant, indicating no difference in the amount of cultivated land per worker, and in the other two, very large increases in size were necessary to enable each worker to cultivate one additional hectare of land.

In general, all of the regression coefficients were low, indicating that the variables used explained only a small proportion of the variance in the proportions of land under cultivation.

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